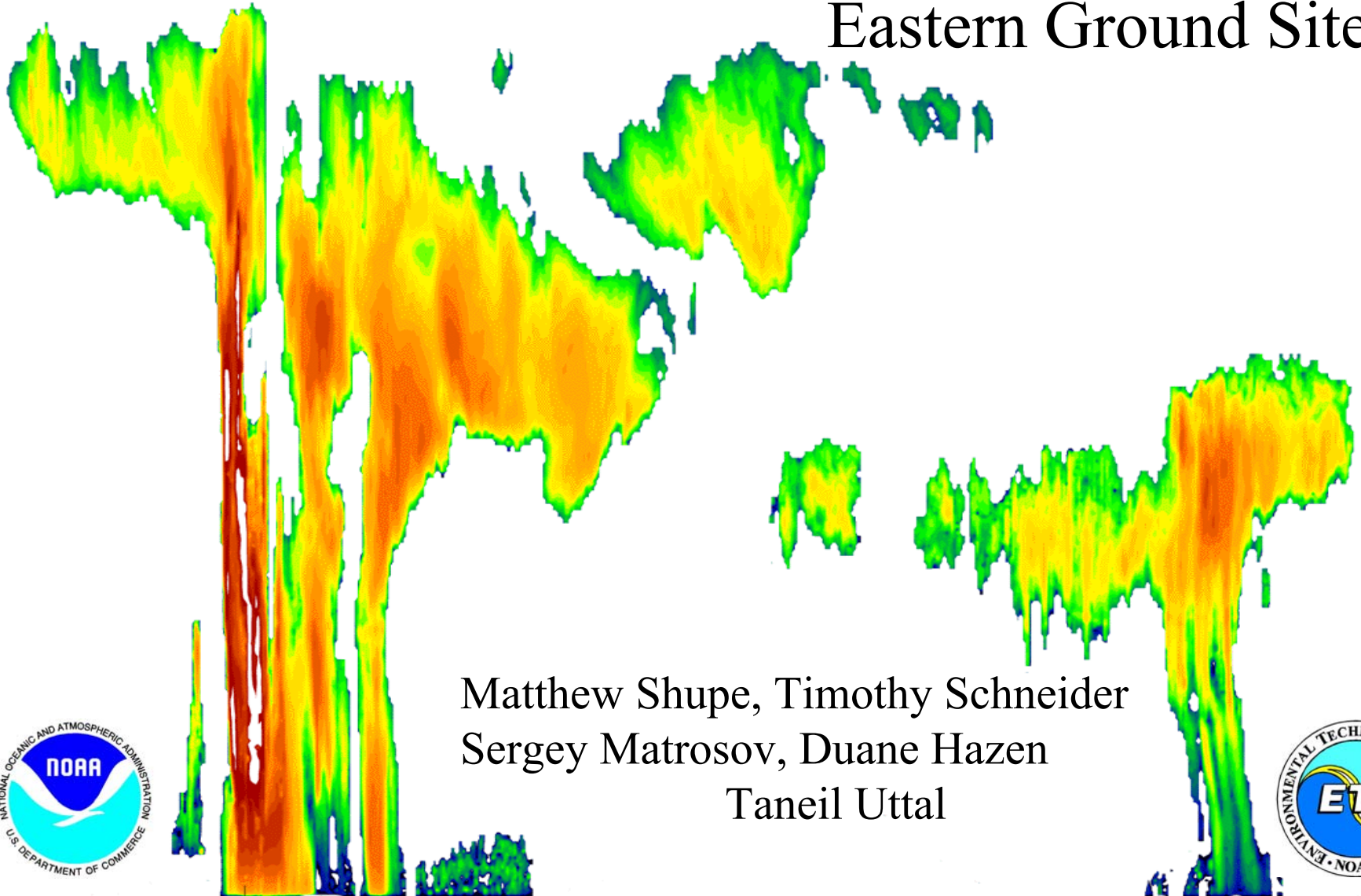


A Complete Time History of Clouds and Cloud Properties Over the CRYSTAL-FACE Eastern Ground Site

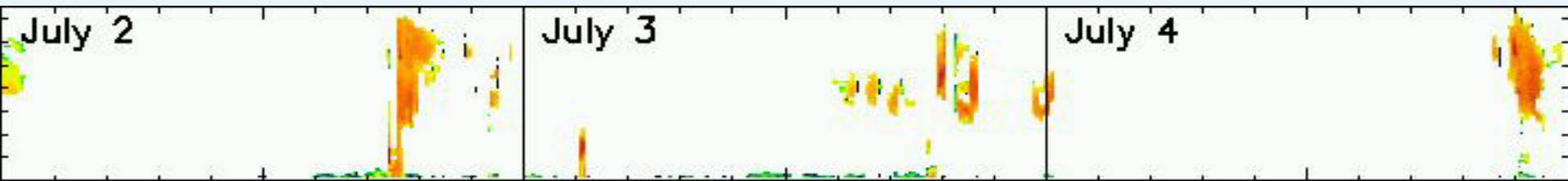


Matthew Shupe, Timothy Schneider
Sergey Matrosov, Duane Hazen
Taneil Uttal



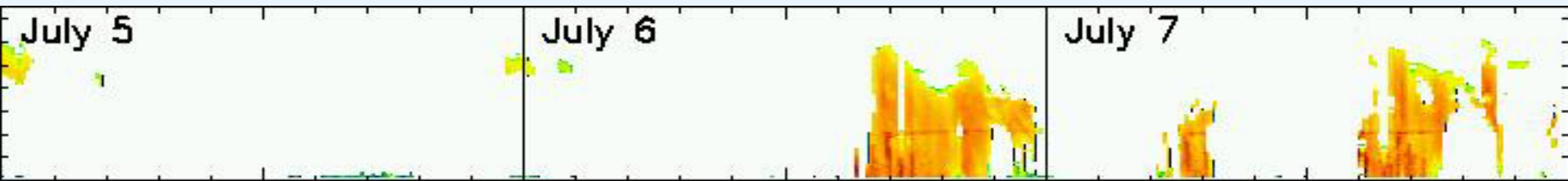
The NOAA Portable Cloud Observatory (NPCO)

- **35-GHz Millimeter Cloud Radar (MMCR)** – Up 98% of time
 - * CRYSTAL-specific operation modes
 - * Up to 45-meter, 10-second resolution
 - * Provides reflectivity, velocity, spectral width
 - * Records full Doppler spectra for each mode
- **Microwave Radiometer (MWR)** – Up 93% of time
 - * 20.6, 31.65, and 90 GHz channels
 - * Brightness temperatures used to derive LWP and PWV
- **IR radiometer**
 - * Provides IR sky brightness temperatures (10.6-11.3 μm)
- **Near real-time internet display**
 - * Radar & radiometer measurements on web within an hour
 - * Derived cloud microphysical products on the web
 - * See www.etl.noaa.gov/programs/2002/fireface
- **Has been deployed on land and ship on 6 projects in 3 years**

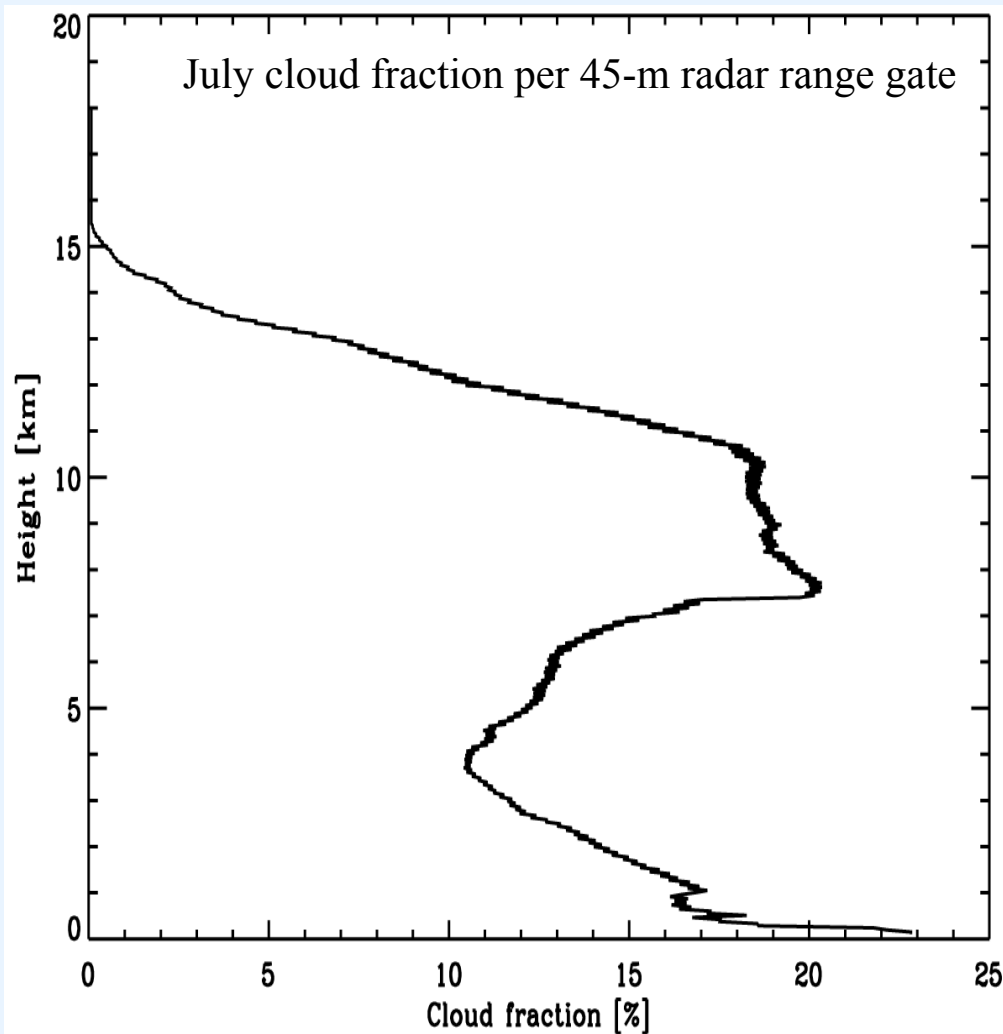


What do NPCO observations provide?

- 1) Cloud Identification → cloud occurrence, cloud vertical distribution, cloud type identification, continuous record of cloudiness, cloud temperature (with soundings).
- 2) Cloud microphysics and extinction retrievals → Apply multiple retrieval techniques (see Matrosov et al. poster) to retrieve profiles of size, water content, and extinction for cloud ice and liquid. Exploring the use of Doppler spectra in cloud retrievals.
- 3) Radiative transfer modeling → Run radiative transfer codes using retrieved microphysics to produce heating rate and flux profiles (see Shupe et al. poster). Thermodynamic state parameters are derived from Miami soundings.

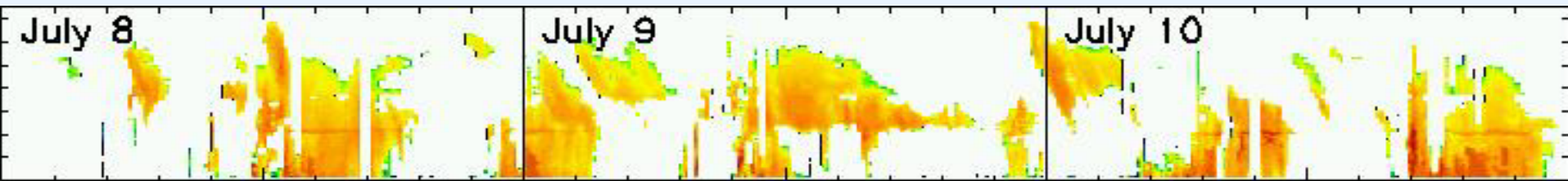


Cloud Identification



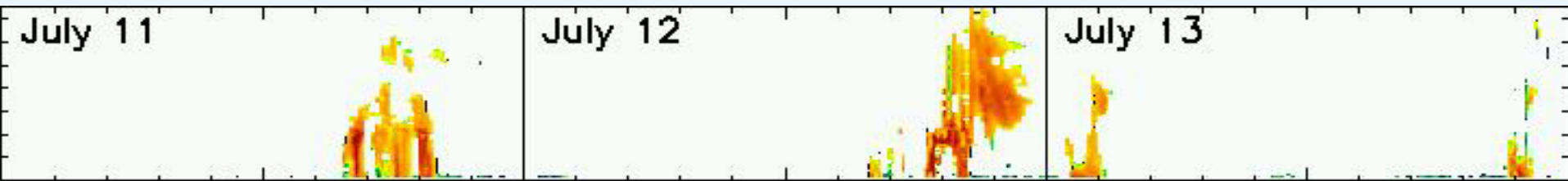
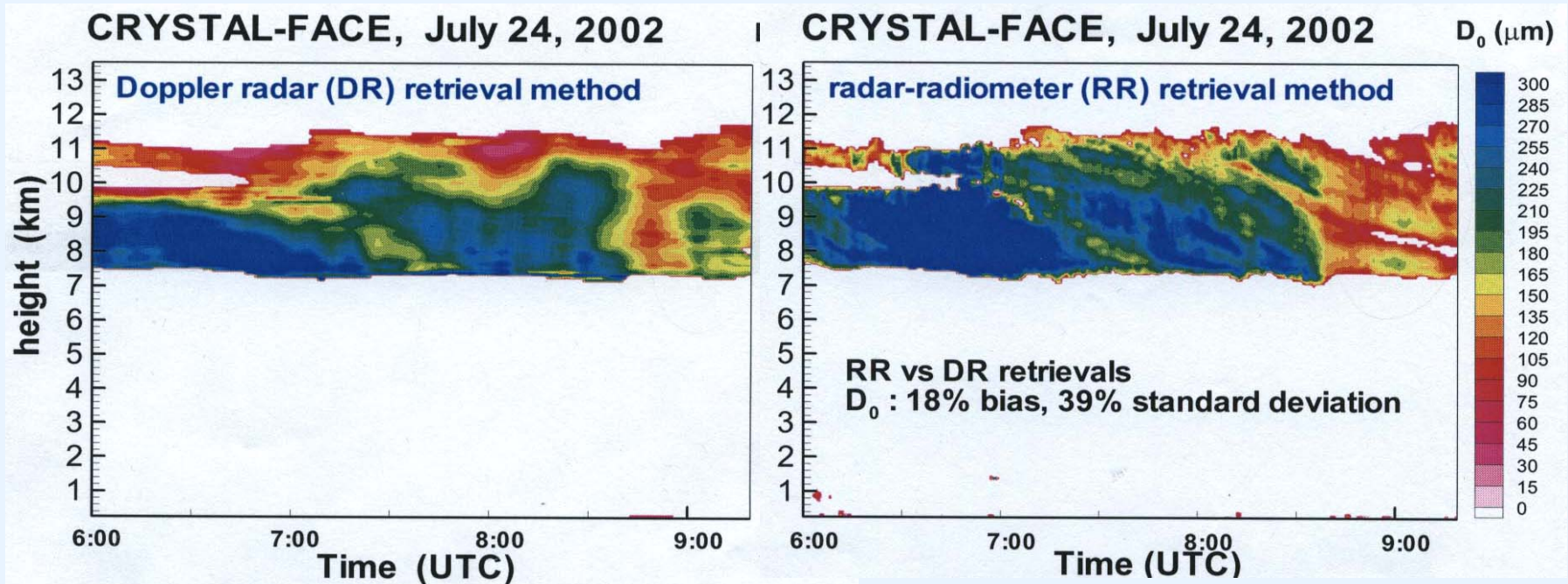
CRYSTAL-FACE Cloud Occurrence [%]

Total	52
Ice Present	41
Liquid Present	12
Mixed-phase	4
Rain/Drizzle	20
> 5 km	42
1 to 5 km	24
< 1 km	25



Cirrus cloud microphysics retrievals

- Use a suite of retrieval techniques: radar-radiometer, radar moments, and empirical reflectivity. Reasonable agreement between techniques.
- Need more aircraft validation and a broader inter-comparison of techniques (i.e. Mace retrievals).
- See Matrosov et al. poster

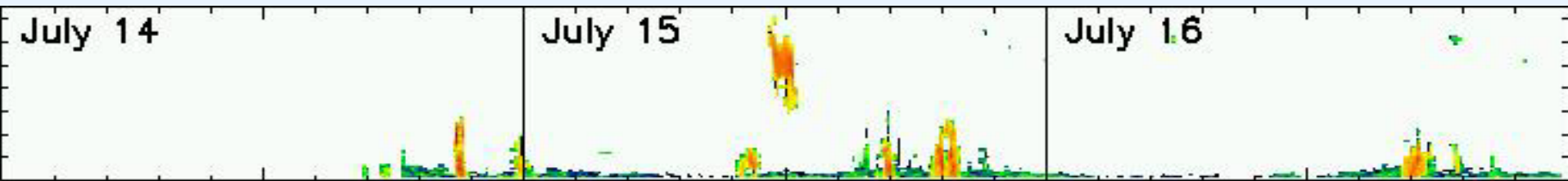
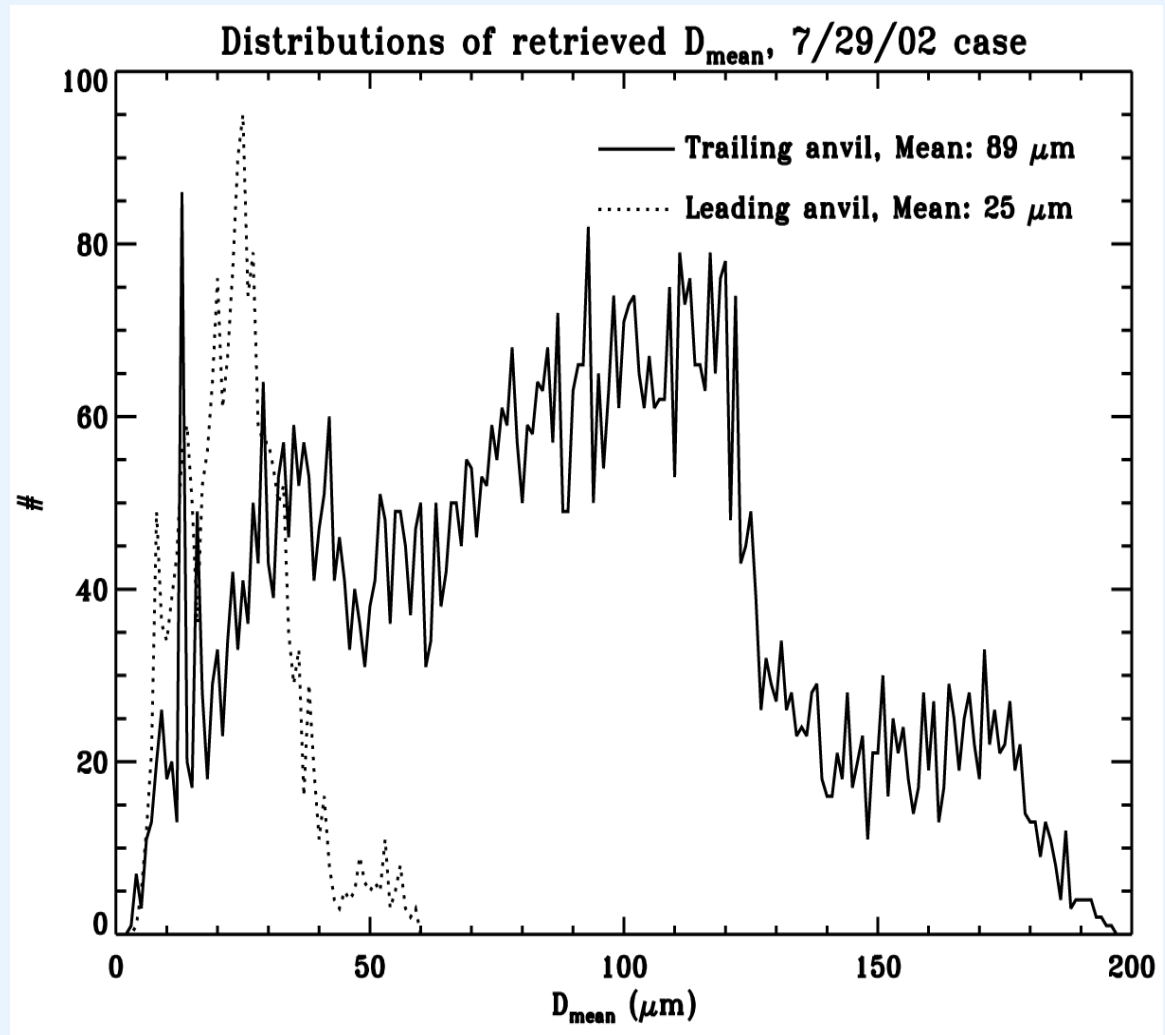


Anvil cirrus properties

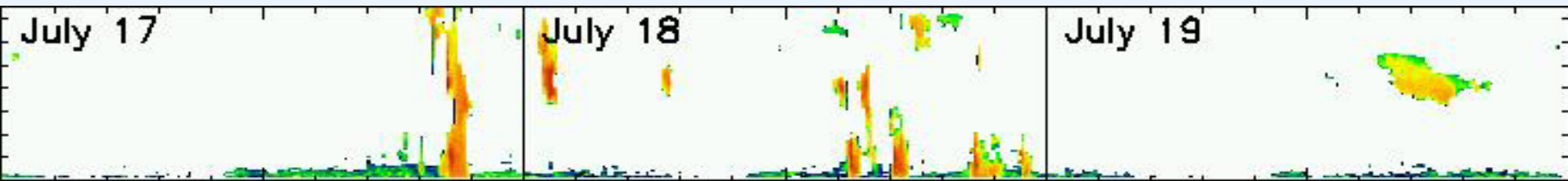
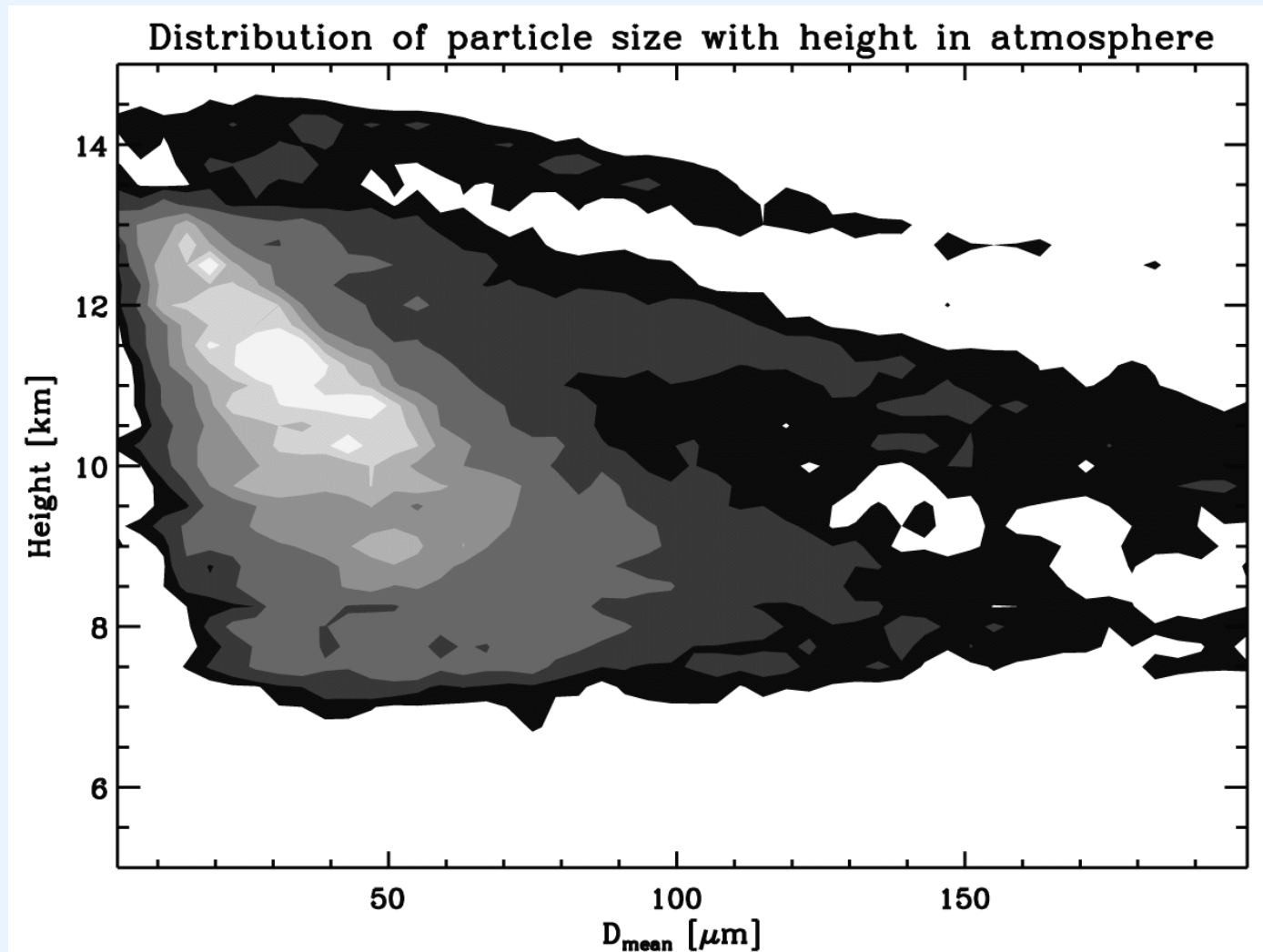
Observed ~32 hours of anvil cirrus and over 150 hours of total cirrus during the month of July.

Anvil statistics

	Mean	Std Dev
$D_{\text{mean}} [\mu\text{m}]$	110	100
IWC [g/m^3]	0.06	0.2
IWP [g/m^2]	85	110
Ext [km^{-1}]	1	2

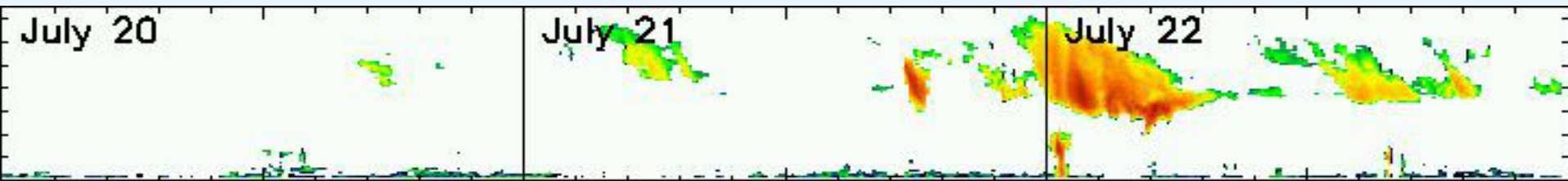
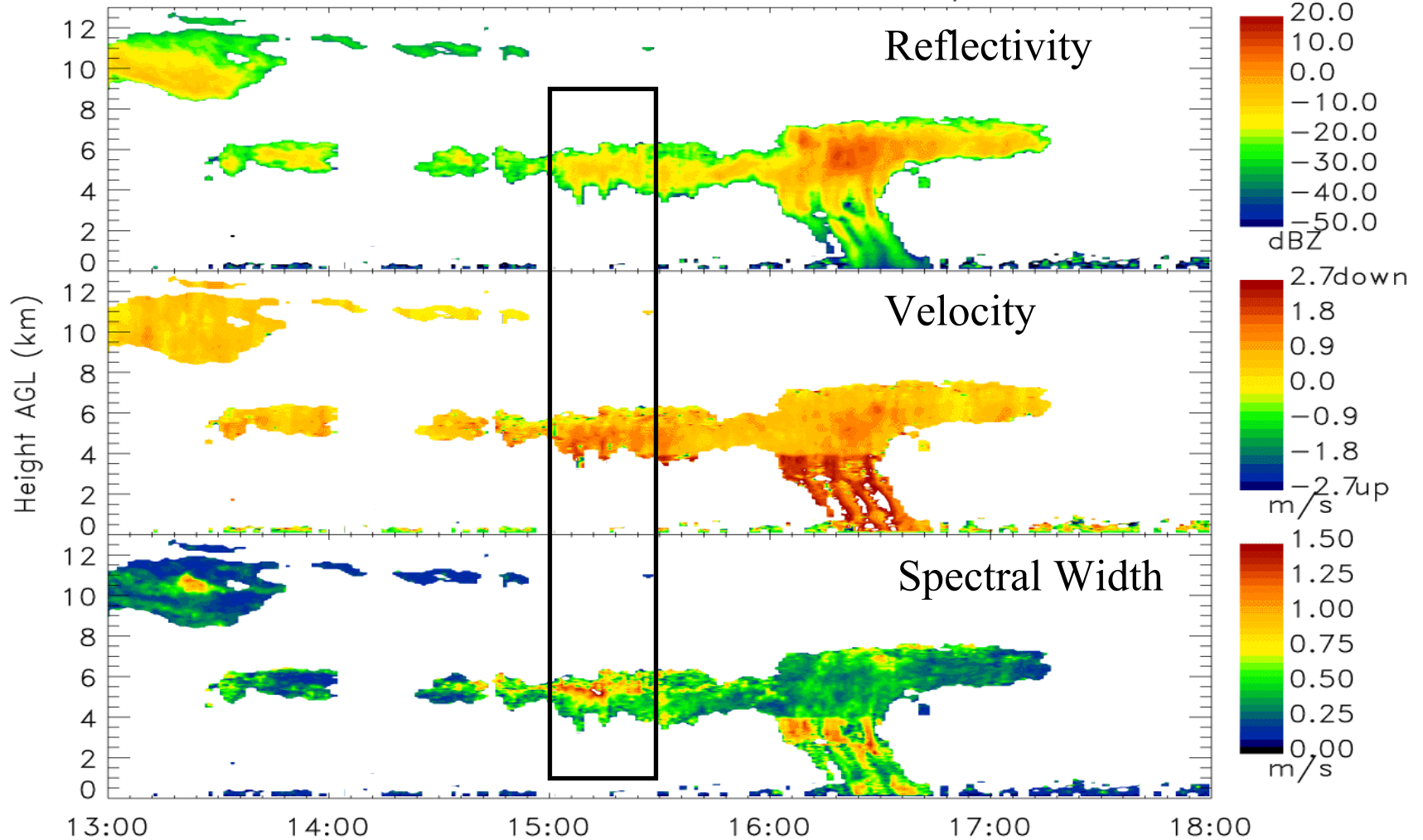


Anvil cirrus properties

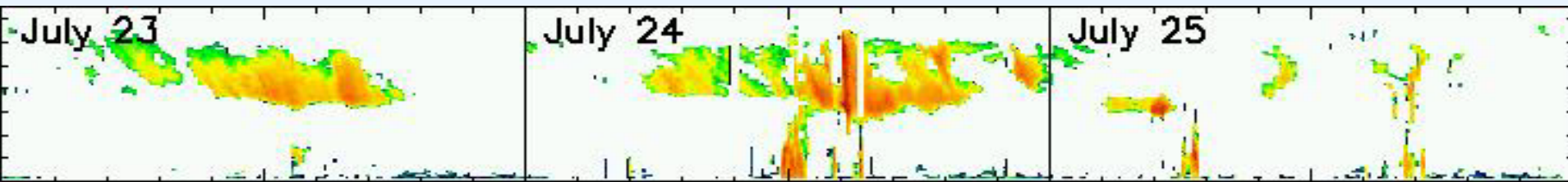
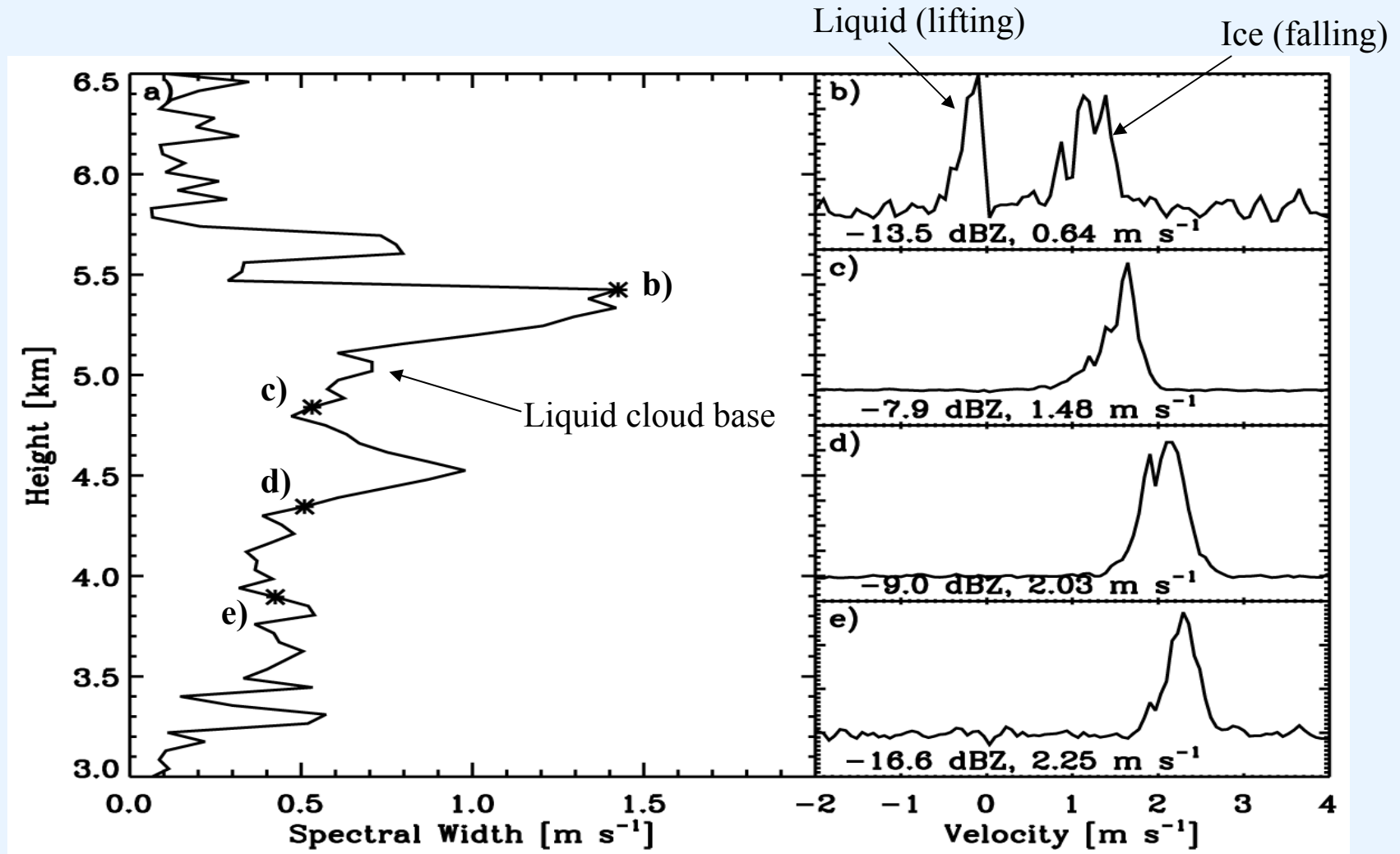


New use of radar Doppler spectra: Mixed-phase clouds

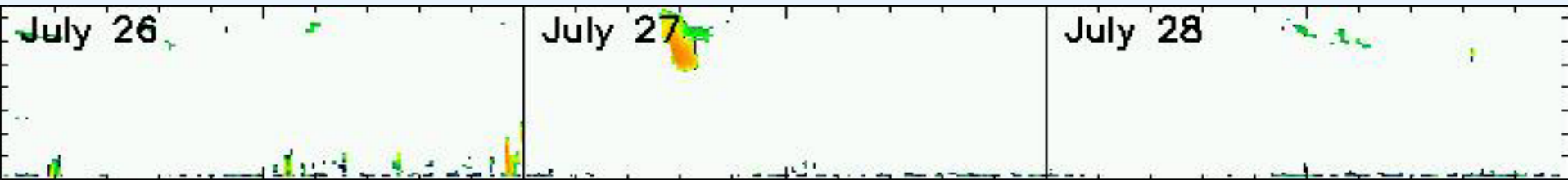
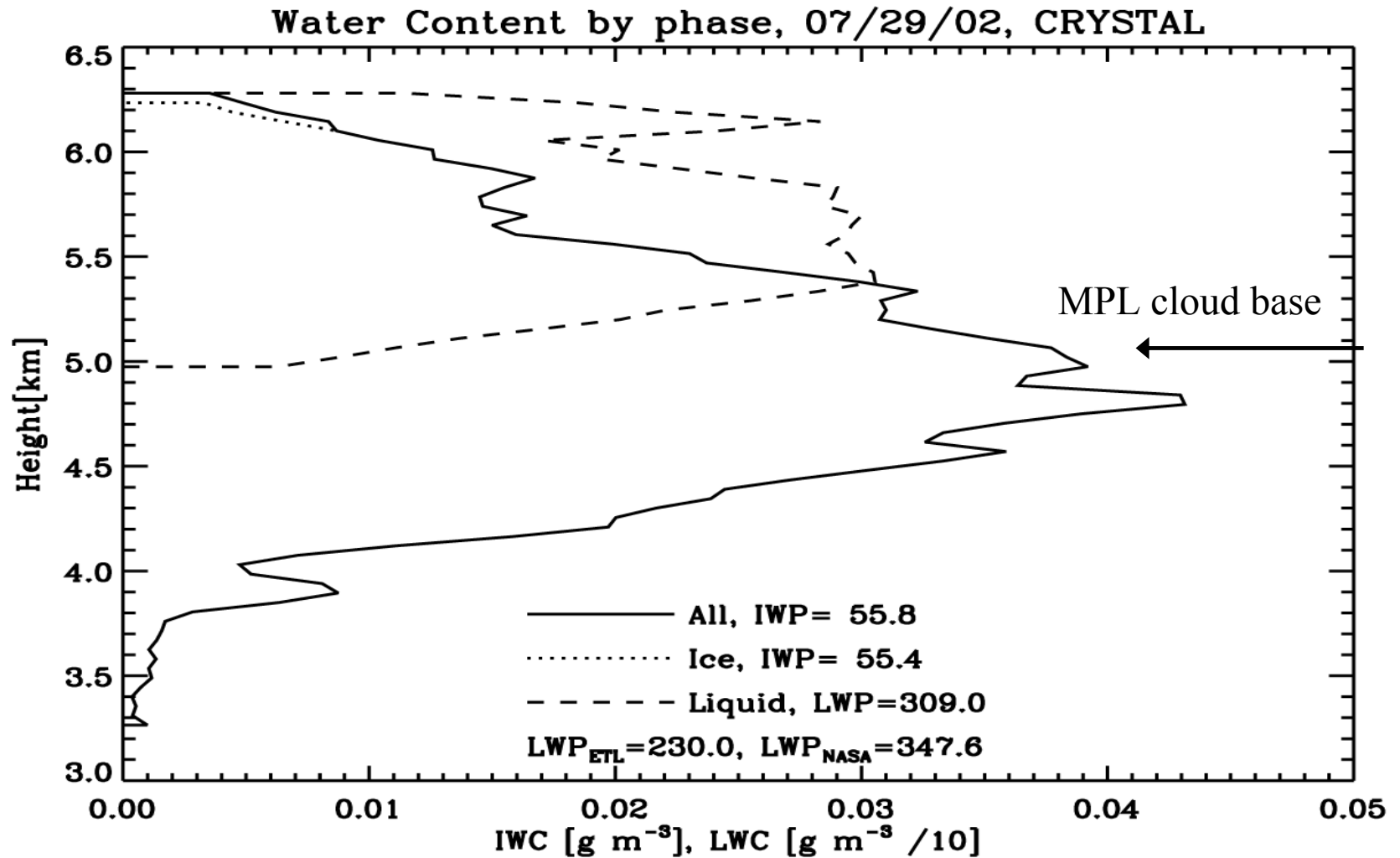
FACE, Millimeter cloud radar data for July 29, 2002



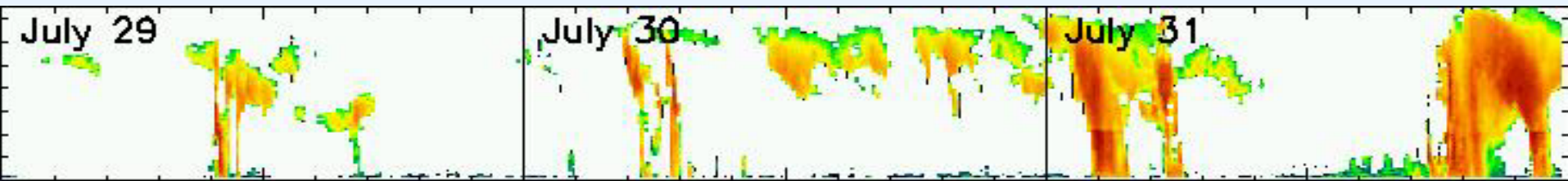
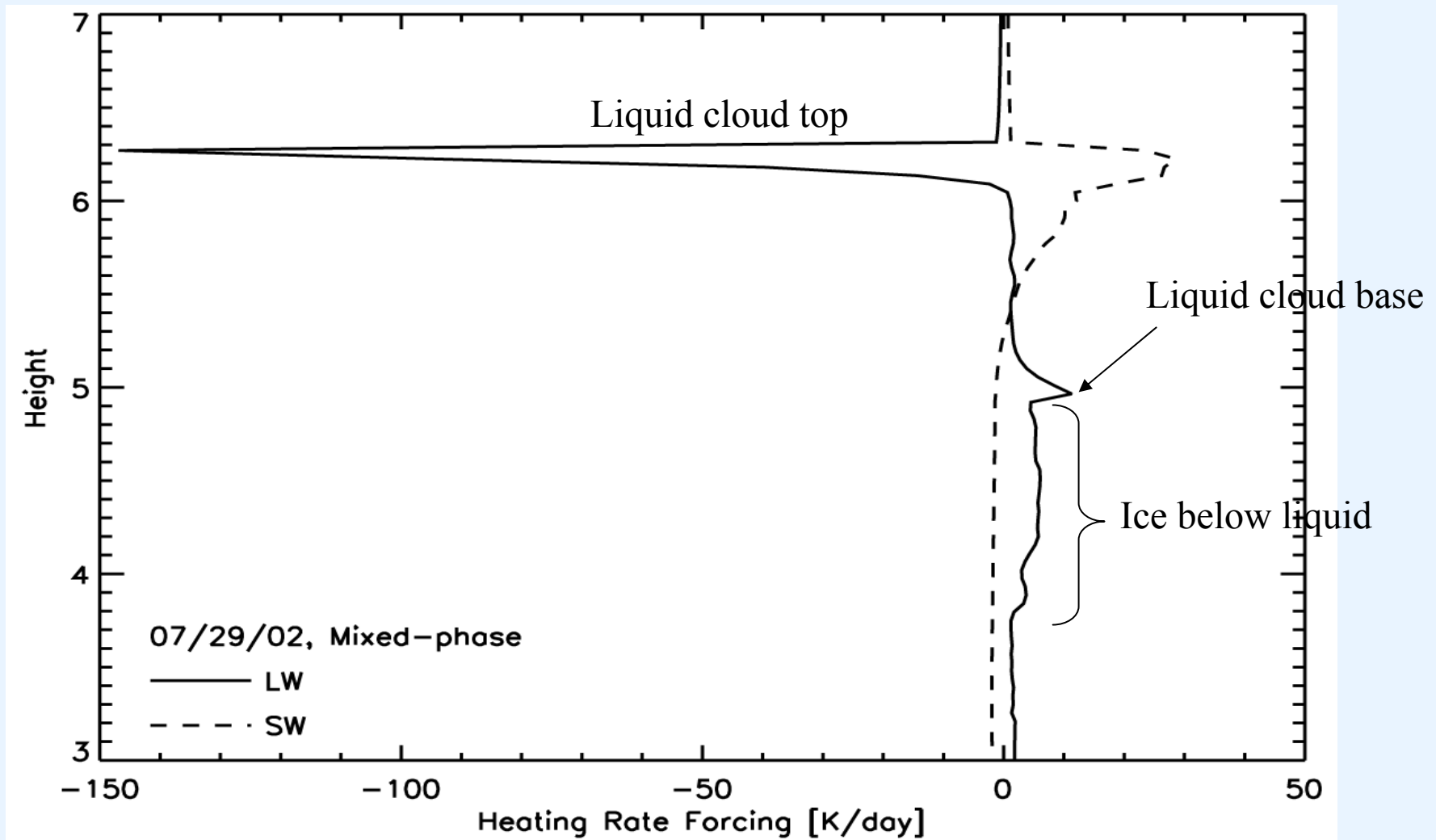
Mixed-phase cloud retrieval from Doppler spectra on July 29th



Retrieved liquid and ice water content profiles



Heating Rate Calculations



Summary

- NPCO data stream was continuous for the CRYSTAL month, showing full time-height cross-sections of the atmosphere, the evolution of cloud systems over time, and the diurnal cycle.
- Measurements and retrievals can be used to characterize cloud properties, to validate satellite retrievals/observations, and to assess models.
- A new technique has been developed for using Doppler spectra.
- Need coincident aircraft measurements to validate techniques (i.e. tie-down points for the continuous data record).

Future work

- Collaborate with Eastern ground team to fix calibration issues (pre 7/14).
- Assess quality of microphysical retrievals to ensure consistency.
- Reprocess all products with updated information.
- Science!! Use radar spectra and multiple radar frequencies in retrievals (with others from the ground site team), further characterize microphysical and radiative properties of cirrus, more satellite intercomparisons.